An Economy at Risk

Why We Need to Organize Our Universities, Health Care Institutions, and Technology Businesses to Compete with Other States

Strategic alliances of universities and businesses in New York, California, and other states — with active support from state government — are challenging Massachusetts' leadership in the critical technologies that will drive the next economic boom.

Massachusetts has had no coherent science and technology-based economic development strategy to meet this challenge... so far.

Mass Insight CORPORATION

SIXTH ECONOMIC GROWTH REPORT — WINTER 2002/2003

“There is a growing recognition that a new science and technology-based economic development strategy is needed for Massachusetts and needed soon.

“If we work together to sustain the quality of our academic institutions, and build and support businesses that depend on constant innovation, the recovery will be accelerated and enhanced.

“If we are timid and fail to pursue a coordinated plan, we shall have squandered the legacy that has served our citizens so well for so long.”

— William M. Bulger, President, University of Massachusetts

— Charles M. Vest, President, Massachusetts Institute of Technology

From “Investing in Our State’s Future,” published in The Boston Globe, Sunday, November 17, 2002. The full text of the op-ed is on page 42.

Mass Insight Corporation

An Economy at Risk

Massachusetts needs a science and technology-based economic development strategy.

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Special thanks to **IBM** and the **Mass. Health and Educational Finance Authority** for their support in preparing this report.

We appreciate the ongoing participation and support of the **Massachusetts High Technology Council** in the preparation of this report and the development of the **Science and Technology Initiative**.

This Sixth Economic Growth Report is a publication of Mass Insight Corporation, a Boston-based public policy firm dedicated to improving Massachusetts' economic competitiveness.

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Mass Insight CORPORATION

Overview

In Massachusetts, we are *all* high tech – and our future depends on it.

Regional economies look different across the Commonwealth. But behind those differences lies a single catalyst for economic growth: science and technology innovation.

It is not hard to understand why. The interaction in Massachusetts between higher education and business feeds a system of innovation. Corporate R&D and academic research from our universities are converted into production advances that are managed by a highly skilled, highly educated labor force.

The talent Massachusetts offers at all levels attracts businesses, which rely on technology and research. Access to talent is what attracted Novartis and other pharmaceutical companies to the state. It is also why Gillette has continued to invest in its South Boston facility. Al Zeien, the former CEO of Gillette, once said that the workforce in Massachusetts made it one of the greatest places in the world to locate advanced technology manufacturing.

None of this is surprising in the great technology concentrations in Boston and around Routes 128 and 495.

But it is also the story outside the I-495 loop, where manufacturing dominates employment and counts for almost 75% of the economic base, as Mass Insight Corporation found in its 1999 Economic Growth Report on manufacturing, *Made in Massachusetts*. The manufacturing businesses that have survived the long decline in the state — from American Saw and Manufacturing in Longmeadow to the textile companies Quaker Fabrics and Satkin Mills in the southeast to Nypro, a Gillette injection-molded plastics supplier in Clinton — have done so by moving up the technology food chain.

Even in financial services, technology is at the core of our important businesses. Fidelity Investments considers itself an information technology company, more than a brokerage. Thousands of employees there are principally engaged in IT applications, and Fidelity depends on innovations and skills developed at our universities to move its business forward.

"SUNY Albany Gets $150 Million for Development of Microchips"

"IBM will contribute $100 million to the State University of New York's microchip research and design center here, the largest university grant IBM has ever given, and the state will give $50 million, company and state officials announced today."

— *The New York Times*, April 23, 2002

"California's Matching Grants Yielding Big Results"

"Between 1993 and 1999, 93 unique small and medium-sized businesses received nearly $22 million in grants up to $250,000 each from the California Technology Investment Partnership and matched it with $109 million in private support (in-kind and cash) and almost $106 million in federal R&D funding."

— *State Science & Technology Institute Weekly Digest*, November 15, 2002

"In an environment where other states are aggressively competing for high tech businesses and jobs, it is irresponsible for Massachusetts state government to leave the future of its leading and most promising sectors to chance."

— Ray Stata
Chairman, Analog Devices
Member, MIT Corporation
Founder, Massachusetts High Technology Council

Our competitive advantage in science and technology is at risk.

Technology, research, science – a system of innovation that converts research into advanced commercial production through an educated workforce. Our technology advantage in Massachusetts has supported us through each recent wave of economic rebirth.

The miracle – and the curse – of this competitive advantage is that it has worked largely by auto-pilot, without meaningful assistance from the state. State government has been a bystander, at best, and an impediment at worst, in our economic success.

We have assumed that our heavily private higher education system and the technology marketplace would take care of our future.

Until now, that's been largely correct. Our assets have been sufficient and have obscured the weakness inherent in a state with no strategy to protect and focus its leading assets: the public and private universities, hospitals, and high tech industries.

But in the quiet war for human talent that fuels success in advanced economies — a competition waged across states and international boundaries — Massachusetts' advantage in science and technology is now at risk.

The motto of our approach in the past could have been, "We're smart. Send money." That's no longer enough to beat our longtime competitors in New York and California and newcomers in Colorado and Texas.

Our competitors are seeking to "eat our lunch," in the phrase repeated, interestingly, by several highly-placed interviewees for this report.

Research universities, teaching hospitals and businesses in other states are creating new and larger concentrations to challenge us in life sciences and in the physical and engineering "hard sciences." These strategic alliances are based on sharing core competencies to mutual advantage, as businesses have learned to do over the last 20 years.

High tech executives and academic deans alike tell us that Massachusetts is, for the most part, a difficult place to establish these strategic alliances or to gain the government coordination and support they need to build new labs, for example, or expand the supply of trained lab technicians. This is certainly a product of a fragmented marketplace: a smaller, uncoordinated public system; large, independent private colleges, and now a predominance of smaller companies. But it is also a failure of will.

AN ECONOMY AT RISK: PART OF AN ONGOING INITIATIVE

Throughout six years of interviews for Mass Insight Corporation's series of Economic Growth Reports in the 1990s, executives have consistently identified higher education and the science and research produced in our universities as a major reason to do business in the state.

Taking that cue, Mass Insight compared the links between business and higher education in Massachusetts to those relationships in other leading technology states in its report, *A Call to Action*, released in late 2000.

A Call to Action Rates Massachusetts Poorly on University/Business Collaborations

High tech executives and academic deans expressed universal concern in that report that Massachusetts was a more difficult place in which to make these connections than California and other competitor states. They emphasized the importance of these collaborations to attracting business expansions and new jobs to the state.

(continued on next page)

"To a large degree, Massachusetts state government has been a passive observer of past success, and, if anything, has been more responsive to those, who in our view, stand in the way of progress," said Ray Stata, Chairman of Analog Devices Inc., in a speech at the Massachusetts High Tech Council's 25th Anniversary Dinner on October 1, 2002.

In other states that look like Massachusetts — or want to — state government is no longer a bystander. Governors and their staff (and other governors have senior staff to lead these efforts) have established technology road maps and made higher education the center of their economic development strategy. They facilitate collaborations between public and private higher education institutions and business and provide the state match funds that, increasingly, federal and business research grants require.

Massachusetts needs a coherent science and technology strategy, focusing on higher education, that comes directly from the top.

"In an environment where other states are aggressively competing for high tech businesses and jobs, it is irresponsible for Massachusetts state government to leave the future of its leading and most promising sectors to chance," charges Stata, who is a member of the MIT Corporation and a founder of the Massachusetts High Technology Council.

We are all high tech in Massachusetts. The state needs its political leadership — beginning with Governor Mitt Romney — to remake our economic development strategy, framing it around science and technology, with higher education as the central lever.

Tight economic times are precisely the moment to re-assess our most critical assets and determine how to promote economic growth and create new jobs. Important steps can be taken with very modest amounts of funds, and states can leverage new private investment by building matching requirements into their funding programs.

Some of the agenda can be accomplished without new funding. But to the extent new funds are needed, the capital budget is the primary option competitor states are using to invest in research capabilities as they face similar budget crunches.

Our two most significant competitor states — New York and California — are led by governors, one a Republican and the other a Democrat, who have understood this paradigm shift and organized their states to support the leading research universities and technology industries and facilitate strategic alliances.

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University and Business Leaders Organize Science and Technology Initiative

Since that call to action, Mass Insight has organized a series of meetings with university leaders and business executives to draft a mission statement and short- and long-term priorities for a Science and Technology Initiative.

In the business community, the overall effort is being led by the **Massachusetts High Tech Council** and **Associated Industries of Massachusetts** (AIM) in cooperation with sector associations, including the **Mass. Biotech Council** and other groups representing the life sciences and "hard sciences." Mass Insight is both coordinating and staffing the initiative.

During the 2002 gubernatorial campaign, as a part of the initiative, four high tech CEOs and the CEO of Partners HealthCare sent an open letter (see page 5) to the candidates, encouraging them to debate and discuss the need for a science and technology-based economic development strategy, and expressing their willingness to assist the next governor with the initiative.

(continued on next page)

New York, with its Massachusetts-like concentration of major private universities including Columbia, NYU, Cornell, the University of Rochester, and Rensselaer Polytechnic Institute (RPI), offers a particularly noteworthy — and worrisome — example. Under Governor Pataki, the state continues to build up the State University of New York (SUNY) as a research powerhouse, also providing incentive funds for collaborations between SUNY and the independent universities and businesses like IBM to establish world-class research combinations. Similarly, even with a private superstar in Stanford University at hand, California has seen fit to develop and invest in a world-class public university, state universities, and community college system.

How do we start? With a personal commitment, a technology inventory, and a technology-based economic development road map.

The first priority is for Governor Romney to make a personal commitment and assign senior-level staff responsibility to organize the fragmented agencies of state government and public higher education to work with business and the private universities.

The core strategy should be built on a technology road map developed with our public and private universities and with health care and high tech executives. This will identify critical technologies, our strengths, what universities and business need to compete, and priorities to create and expand strategic alliances between the major players in Massachusetts, including UMass, the private universities, the teaching hospitals, and business.

The strategy should create a broader framework for workforce, real estate and funding priorities, including community college strategies, real estate and permitting issues for major research projects, match funding needs, and a federal funding advocacy agenda for a Massachusetts coalition led by the governor. (See the five recommendations in the letter at right, and the Strategy Framework on page 25.)

The installation of a new governor and leadership team in the State House offer a critical opportunity to re-frame the state's economic development strategy and use state government wisely. The choice facing Governor Romney and other state leaders: Take our economic strategy off "autopilot" and maintain Massachusetts' technology advantage through a new coordinated economic plan or do nothing — and put that advantage and the future of the Massachusetts economy at risk.

— William Guenther
President, Mass Insight Corporation

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Both candidates endorsed the initiative's broad agenda.

Subsequently, presidents Charles Vest of MIT and William Bulger of UMass co-authored an editorial for *The Boston Globe* (November 17) endorsing the need for a science and technology-based economic development initiative. (see page 45)

An Economy at Risk, the follow-up report to *A Call to Action*, draws from the meetings held this year with university and business leaders and from an extensive new round of interviews with other executives representing public and private stakeholders (see list in Appendices). Mass Insight acknowledges with deep appreciation the active participation of so many prominent leaders in these discussions and in the development of this report.

We are also grateful to the report's sponsors, whose support ensures the widest possible distribution for *An Economy at Risk*.

October 7, 2002

An Open Letter to the Republican and Democratic Nominees for Governor (excerpts):

While some factors that determine economic success are beyond any state's control, the next governor can, and must, take a strong and consistent leadership role to assure that Massachusetts remains a leading science and technology development state and that all regions of Massachusetts have the opportunity to participate in the innovation economy. We cannot rest on past fame and current success, and we can no longer be complacent.

Governors in other states have already implemented coordinated programs to support university research, promote technical workforce development, and to encourage collaborations among their business and public and private academic sectors. These states are also under severe budget pressures, but they are managing to protect and even expand funding for research facilities and public higher education. They know the difference between cutting overgrowth and killing seed corn.

That's why we are aligning with our colleagues — corporate and university leaders — to identify and support science and technology education and research initiatives that will enhance our current economic strengths and protect our competitive position — in both life sciences and the "hard sciences" of engineering and technology.

We will soon be sending you a more detailed memo about the need for gubernatorial leadership and action to:

— Increase collaborations among public universities, private universities and Massachusetts businesses;
— Accelerate the development of the UMass system as a leading-edge technology university;
— Support initiatives that coordinate sci tech research by private campuses with the public higher education system;
— Continue steps toward improved K-12 math and science education;
— Play a more active role in seeking federal research funding.

We are keenly aware of the serious pressures you will face on both the operating and capital budgets. Rather than additional spending, many of the steps we propose require more assertive leadership, better management and greater coordination of current investments, programs and policies. But to be frank, additional spending, especially on public higher education and new science and technology collaborations, may be needed. But any new spending should be targeted carefully to build on our science and technology strengths and must be part of a fundamental state policy that sustains a comprehensive system of innovation.

In collaboration with leading business organizations, including the Massachusetts High Technology Council and Associated Industries of Massachusetts, we are joining with Mass Insight to help identify a public agenda for our institutions and the state. We are reaching out to leading sector associations including the Massachusetts Biotechnology Council to incorporate their priorities into this broad-based leadership initiative.

We are asking you to commit to establishing a coordinated higher education, science and technology strategy as the core of the state's economic development agenda.

We are developing our Science and Technology Initiative and look forward to meeting with the governor-elect during the transition to offer all the assistance that we and our colleagues can provide on this critical issue at this critical time.

We look forward to participating with you in this process.

Sincerely,

Ray Stata
Chairman of the Board
Analog Devices, Inc.

George W. Chamillard
Chairman and CEO
Teradyne, Inc.

Corinne Johnson
General Manager and Lynn Area Executive
G.E. Aircraft Engines

Michael C. Ruettgers
Executive Chairman
EMC Corporation

Dr. Samuel O. Thier, M.D.
President and CEO
Partners HealthCare System, Inc.

A United Front: This letter, sent by five prominent executives to both gubernatorial candidates in October 2002, was embraced by both campaigns.

An Economy at Risk

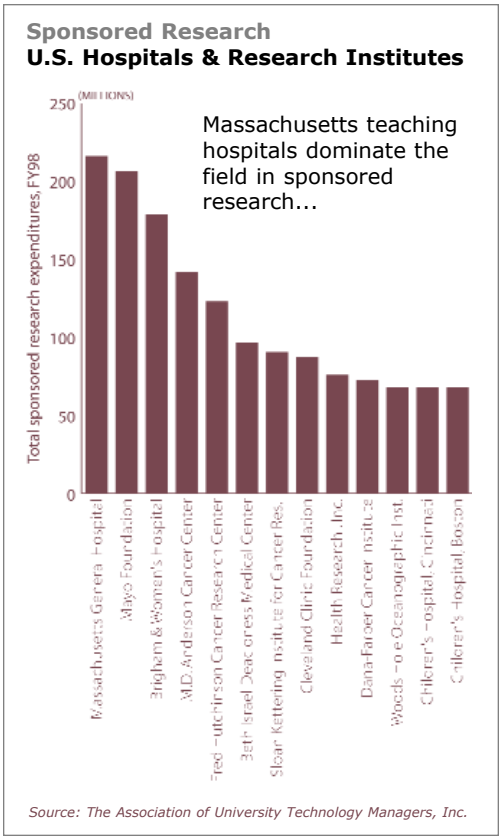
Massachusetts needs a science and technology-based economic development strategy.

"It's incumbent on Massachusetts government, universities and industry to do a much better job of technology auditing and forecasting. We need to collaborate more effectively and develop a technology road map that looks five or ten years down the line. Otherwise, we're likely to turn into Cambridge, England: we'll have the very best university research but none of it will be linked to local industry. We'll create all the new ideas — but everyone else will get the benefit."

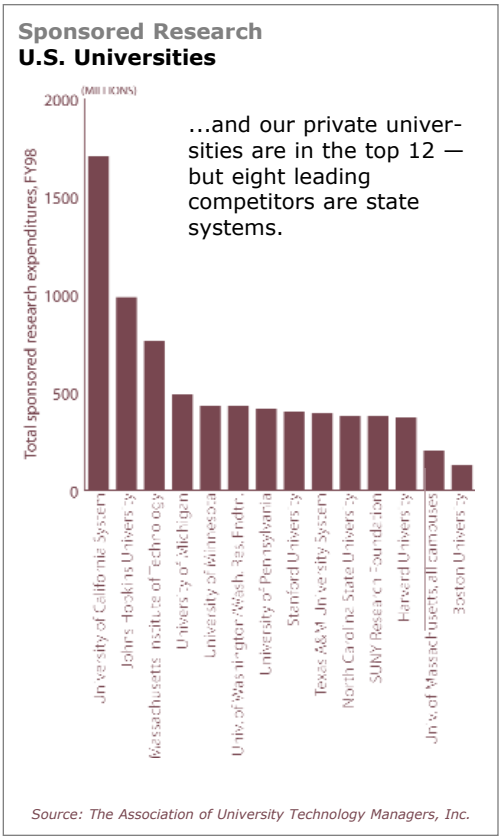
— Michael Best, Director, UMass/Lowell Center for Industrial Competitiveness

As one Massachusetts executive stated in Mass Insight's 2000 report, *A Call to Action*: "Other places are seeking to eat our lunch. They're pitching themselves to us as high tech Meccas. They understand that tax breaks and cheap land are short-term things that are necessary, but hardly sufficient to draw businesses like us. The new paradigm lies in university collaborations with industry and with government."

The current economic downturn, and subsequent difficulty the Legislature has faced in balancing the budget, may leave little latitude for immediately funding a new strategy to support aggressive science and technology investment in our public and private universities and to develop more collaboration with the private sector.



Source: The Association of University Technology Managers, Inc.



Source: The Association of University Technology Managers, Inc.

Even if state appropriations were currently available, Massachusetts has no long-term technology vision or development strategy to which it could apply them. Until we create and fund a comprehensive technology-based economic development strategy,

Massachusetts will continue to provide only limited support for industry-university collaboration, and then only on an ad hoc basis through special legislative appropriations for the University of Massachusetts.

"Nobody wants to hear the term 'industrial policy' anymore, but we do need to consider our technology strategy," says UMass' Michael Best. "California, Georgia, Michigan, and the people behind North Carolina's Research Triangle, just to name a few, have all been pursuing a much more integrated and efficient industrial development strategy than Massachusetts. And the results are evident."

In addition to looking at competitors across the country, state policymakers also need to pay closer attention to how they approach technology development inside Massachusetts' borders, says UMass Vice President Tom Chmura. "If you want to do science and technology-based economic development across the state, you've got to focus on how to develop and capitalize on regional technology centers of excellence. Increasingly, regional leaders in places such as Central Massachusetts, the South Coast and Pioneer Valley think this way. But, these regional efforts need more attention, stimulus and support from the State House."

Massachusetts Research Centers, Universities, and Teaching Hospitals

Massachusetts Research Universities

- Boston College
- Boston University
- Brandeis University
- Clark University
- Harvard University
- Massachusetts Institute of Technology
- Northeastern University
- Tufts University
- University of Mass. at Amherst
- University of Mass. at Worcester
- University of Mass. at Dartmouth
- University of Mass. at Lowell
- University of Mass. at Boston
- Worcester Polytechnic Institute

Selected Research Centers

- Lincoln Laboratory (FFRDC)*
- MITRE Corp. (FFRDC)*
- Charles Stark Draper Laboratory
- Air Force Materiel Command's Electronic Systems Center (Hanscom)
- The Whitehead Institute
- Woods Hole Oceanographic Institution
- MIT's Microphotonics Center
- MIT Media Laboratory
- The Center for Intelligent Information Retrieval - UMass Amherst
- MIT's Institute for Soldier Nanotechnologies
- Harvard University's Bauer Center for Genomics Research
- Harvard's Center for Imaging and Mesoscale Structures
- Boston University Biomedical Engineering Center
- Boston University Photonics Center
- Northeastern's Barnett Institute for Molecular Science
- Northeastern University's Center for Subsurface Sensing and Imaging Systems
- UMass Medical School
- U.S. Army Soldier Systems Center (Natick Army Lab)
- Center for Sustainable Energy
- The Biodegradable Polymer Research Center
- Baystate Medical Center - UMass Amherst Biomedical Research Institute

* Federally Funded Research and Development Center

Teaching Hospitals

- Massachusetts General Hospital, Boston
- Brigham and Women's Hospital, Boston
- New England Baptist Hospital, Boston
- Children's Hospital, Boston
- Boston Medical Center, Boston
- Beth Israel Deaconess Medical Center, Boston
- New England Medical Center, Inc., Boston
- St. Elizabeth's Medical Center, Boston
- Veterans Affairs Boston Healthcare System, Boston
- Faulkner Hospital, Boston
- Veterans Affairs Medical Center, Brockton
- Lahey Clinic Medical Center, Burlington
- Mount Auburn Hospital, Cambridge
- Berkshire Medical Center, Pittsfield
- Baystate Medical Center, Springfield
- St. Vincent Hospital/Worcester Medical Center, Worcester
- UMass Memorial Health Care, Worcester

Selected Mass. research centers are profiled in Mass Insight Corporation's companion directory, an annually updated resource published separately from this report.

Sources include The National Science Foundation and The American Association of Medical Colleges/Council of Teaching Hospitals

Section One:

Five Reasons to Act

Five Reasons to Act

Reason No. 1

Other states are organizing — and threatening to pull ahead.

"Governors in other states, from established competitors such as New York and California to increasingly effective ones such as Colorado and Georgia, have already implemented coordinated programs to support university research, promote technical workforce development, and to encourage collaborations among their business and public and private academic sectors. These states are also under severe budget pressures, but they are managing to protect and even expand funding for research facilities, public higher education and other cornerstones of an innovation economy. They know the difference between cutting overgrowth and killing seed corn."

— Ray Stata, Chairman of Analog Devices Inc.
— George W. Chamillard, Chairman and CEO of Teradyne Inc.
— Corinne Johnson, General Manager and Lynn Area Executive of G.E. Aircraft Engines
— Michael C. Ruettgers, Executive Chairman of EMC Corp.
— Dr. Samuel O. Thier, M.D., President and CEO of Partners HealthCare System, Inc.

... in an open letter to Massachusetts 2002 gubernatorial candidates (page 5)

Like so many others we talked to, these five high tech and health care executives are concerned that Massachusetts is being challenged as a leader and innovator in science and technology.

Today, Massachusetts holds a leading position in many "new economy" indicators, including: patent and small business innovation research (SBIR) awards; federally-funded R&D expenditures; royalties from licensed technology; and venture capital invested.

Moreover, the size and strength of our state's four principal high tech industry clusters — software and computers, telecommunications, defense, and life sciences — is rivaled only by those in California, New York, Texas, Virginia and, to a lesser degree, a few other leading technology states.

Unfortunately, our continued leadership in these areas is far from guaranteed. Many other states are making aggressive and effective bids to gain share in the very same industry clusters that Massachusetts is accustomed to leading.

New ideas are a key ingredient not only to stay ahead of the pack, but to maintain a strong economy. Indeed, according to the Mass. Technology Collaborative, nine "innovation clusters" — including both high tech and more traditional industries — account for 25 percent of all non-government employment in the Commonwealth; in all, more than 720,000 jobs. Each of these nine clusters, from software to healthcare technology to financial services, requires a continuing stream of new science and technology to remain competitive.

Many competing states have developed well-funded strategies to support their university-based R&D and link it to local industry — in some cases creating industry-university research consortia involving hundreds of companies, and tens of millions in funding from state, federal and industry sources.

In 2001, for example, the Texas governor and legislature joined together to invest more than $300 million in science, engineering and technology transfer. The package included $300 million to be spent on a statewide network of science, research and engineering facilities at Texas colleges and universities, while $45 million was dedicated to product development and incubator activities, with an emphasis on biomedical and bioscience projects.

Such state-supported initiatives have one goal — to dominate the next wave of innovation in critical technology areas like nanotechnology, microphotonics and biomedical engineering. These are the same technologies that Massachusetts companies will need to dominate if they wish to remain competitive. If policy decisions in other states allow them to catch up and eventually pass us, Massachusetts risks ceding the title as the nation's "science and technology headquarters" to California, New York, and Texas.

WHO'S INVESTING IN THE FUTURE?

STATE	NEW STATE INVESTMENT	STRATEGY
New York	$283 million	Create world-class regional public and private research centers in nanotechnology, bioinformatics, photonics
California	$400 million over five years, to leverage $800m in corporate investment	Create university-based centers to foster greater collaboration between academic scientists and industry entrepreneurs in biotech, nanotechnology, and IT
Texas	$300+ million	Enhance science, engineering, and technology transfer, in part through statewide university-based network of research facilities focusing on biomedicine, bioscience
Massachusetts	$0	No coordinated higher education/science and technology strategy.

Competitor Spotlight

NEW YORK
Aggressive Investment in Public/Private Research Partnerships Generates Results

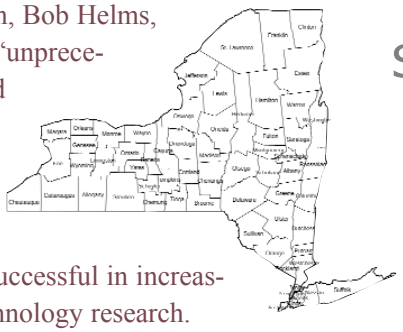
Massachusetts need only look across its western border to New York, which has a similar concentration of private universities, to see the impact of a science and technology strategy and state investments. Last year, New York Governor George Pataki pledged $283 million in new state funding to create world-class technology research centers for bioinformatics, photonics and nanoelectronics through collaborations between business and his state's public and private university system. The program is designed to leverage $700 million in federal, university and private research expenditures over five years.

In the spring of 2002, one $50 million grant, creating the SUNY Albany's Center of Excellence in Nanotechnology, was matched by $100 million from IBM to fund a

microchip research and development center. The project has an additional public-private component, building on the relationship the state and IBM helped develop between SUNY Albany and the nearby RPI. IBM has also invited Albany's professors and graduate students to work with the company's top scientists at its new $2 billion East Fishkill semiconductor fabrication plant.

Subsequently, the consortium International SEMATECH, which includes IBM, decided to locate its $400 million computer chip research and development facility at the Albany Center of Excellence. In announcing the decision, Bob Helms, President and CEO of International SEMATECH, cited the "unprecedented opportunity to maximize the leverage of industry and state government investments."

NEW STATE FUNDING FOR RESEARCH



$283 million in 2001

The only other project of this magnitude endorsed and partly funded by SEMATECH was in Austin, Texas in the late 1980s. The investment in Austin proved to be hugely successful in increasing economic growth and helped make Austin a hub for technology research.

Other Centers of Excellence have been announced in Buffalo in bioinformatics, in greater Rochester in photonics, in Syracuse in environmental systems and on Long Island in information technology.

New York's lead state agency for this effort is the New York State Office of Science, Technology & Academic Research (NYSTAR). Created as part of the landmark Jobs 2000 Legislation, NYSTAR has an eleven-member Advisory Council, and will have approximately 44 full-time employees when fully staffed. NYSTAR is part of the Executive Branch in New York and is overseen directly by Governor Pataki. NYSTAR has been provided $120 million and oversees five Centers for Advanced Technology and ten Technology Development Organizations across the State.

Competitor Spotlight

CALIFORNIA
2:1 Match Funds Create More "Bang for the Buck"

California has announced even more ambitious plans than New York to foster cooperation between the state, industry and higher education. Despite tight fiscal times, California will use its capital budget to guarantee $400 million in state funding over four years (four centers at $25 million per year) — but only if it is matched by more than $800 million from industry and other sources. Like New York, California has established university-based centers of excellence whose primary goal is to foster greater collaboration between academic scientists and industry entrepreneurs.

California's university-based R&D centers are designed to accelerate technology transfer, commercialize new products, and create new companies in biotechnology, bioengineering, nanoscale electronics, and information technology: four research centers in all, each with a distinct industry and application focus. Hundreds of technology companies have joined consortia sponsoring the centers, all of which are meeting their goals to raise 2-to-1 industry-matching funds. Indeed, the program has been so well received by industry that, despite the economic downturn and resulting state budget shortfalls, California Governor Gray Davis and the legislature actually accelerated the state's investment by issuing bonds. To be sure, Davis is trimming funds allocated to some parts of California's university system — but not those intended to create the next wave of innovation.

NEW STATE FUNDING FOR RESEARCH

$400 million 2002-2006

The Division of Science, Technology and Innovation (DSTI), created by Governor Gray Davis in 2000, is California's lead organization for technology-based development. DSTI is part of the Technology, Trade & Commerce Agency, the state organization responsible for economic development, job growth and job retention in California, with a budget for FY 2002-03 of $772.4 million. DSTI's mission is to nurture and foster California's tech-based economy by working with federal and local governments, non-profits and California-based private companies. With a staff of 20, DSTI serves both as an advisory council to the governor as well as an agency with its own autonomy, enabling it to administer funds and grants in order to help companies bring their technologies from the lab to the marketplace.

Competitor Spotlight

PENNSYLVANIA
Forging a Future During Tough Economic Times

Some states have chosen tough economic times as an advantageous climate in which to implement new initiatives. When Pennsylvania faced economic difficulties in the early 1980s, the state launched the Ben Franklin Partnership to create university-based research centers of excellence and provide seed stage investments in technology companies emerging from, or collaborating with, those labs. Since 1989 the Partnership's participants have created more than 49,000 high tech jobs and boosted Pennsylvania's economy by $2.9 billion, all for an investment of about $4,000 per job. Pittsburgh, once a decaying steel town, now has the nation's third highest concentration of high tech companies in high tech areas such as software robotics and the life sciences.

STATE INVESTMENT PER HIGH TECH JOB

$4,000

RETURN ON INVESTMENT

$2.9 billion since 1989

Reason No. 2

Federal funding for science and high tech research is critical to Massachusetts' future, and the stakes have never been so high.

"The economic foundations of our states will be greatly enhanced by our journey to scientific discovery. Just as technological breakthroughs of the past unleashed the $500 billion computer and telecommunications industry via federally funded research, a new generation of highly skilled scientists and engineers will expand upon the $100 billion biotechnology and pharmaceutical industries, creating pathways to economic growth we have yet to imagine. With the development of these new industries, our states will benefit from the creation of thousands of highly skilled jobs every year.

"A promising, prosperous future depends, in large measure, upon our continued commitment to research. We respectfully urge you to help our nation realize this vision by sustaining federal funding for university research. We are confident that such investment will heighten the competitiveness of our states and improve the quality of life for men, women, and children across our nation and around the world."

— Excerpt of open letter to Congress drafted by Governor William Weld in 1996, who enlisted 26 other governors as co-signers

Governor Weld's letter made a contribution to the successful push by the National Science Coalition of research universities to double the NIH budget. Unfortunately, it represents an isolated event for Massachusetts gubernatorial leadership in Washington, D.C.

On the face of it, Massachusetts research institutions and the companies they spawn have never had it so good. According to the Mass. Technology Collaborative, more than $1.9 billion in federal R&D expenditures flowed into the Commonwealth's university and non-profit research centers in 2000. Over 70% percent of those funds went to the life sciences sector, which employs about 47,000 people. The state's approximately 275 biotechnology companies directly employ about 26,000 workers, and the 264 medical device manufacturers provide jobs for about 21,000.

The "hard science" software and telecommunications services, telecommunications hardware, computers, electronics, and defense sectors employ approximately 225,000 workers in the state. Massachusetts labs and institutes that support these clusters received the other $550 million in federal R&D monies in 2000.

Why has life sciences grown so rapidly, while federal investments in the physical and engineering sciences have languished? One reason, say those we interviewed, is that members of Congress from both parties relate far more easily

to funding proposals that may cure disease than they do to engineering initiatives involving photonics, electronics or software. Companies and universities working on life science R&D have done a good job of making their case when they lobby Congress for increased funding.

Another challenge for university labs and industry clusters that work in the engineering and physical sciences involves the organization of federal bureaucracy. Nearly all life sciences funds come from one agency, the National Institutes of Health, which has become very efficient at dispensing funding. But the physical and engineering sciences are funded by an "alphabet soup" of government agencies including the National Science Foundation (NSF), the Departments of Defense and Energy, and NASA, making it difficult for anyone in Washington, D.C. to create or manage a comprehensive R&D strategy.

Although NIH awards to life sciences have doubled during the past five years, federal funding for basic and applied research in the closely interconnected physical and engineering sciences has lagged seriously behind, according to Jack Crowley, director of MIT's Washington, D.C. office. The result: Each of the Commonwealth's 13 engineering colleges and universities must forego promising research for lack of money.

Even the Bush Administration's military buildup will not help much, says Crowley. Why? Roughly half of all federal research awards in engineering are funded by the Department of Defense, but operational contingencies have forced DOD to redirect these funds for operations and acquisitions. Congressional defense committees and the Defense Science Board have documented serious lags in DOD's long-term investment in defense research programs that spawn new technologies essential to our security, our health, our technological innovation, and our economy.

Making matters worse is increased competition from other states for these scarce research dollars, coupled with a growing trend in Congress to earmark awards for institutions in states with strong political influence in Washington. That combination means Massachusetts researchers developing new science and technology in software, telecommunications, defense, computers and electronics will more than likely see their share of these resources continue to shrink.

In mid-November 2002, the White House and Congress agreed to authorize a new funding path for NSF that, if fully funded, will double their research programs over the next five years. Currently, the bill is on its way to the President's desk. This is very good news, especially for the Foundation's physical sciences and engineering research programs. Although the NIH budget has nearly doubled over the past five years, university administrators and scientists say the federal government's bi-partisan, five-year campaign to double NIH funding for life sciences research may soon end, slowing the growth of NIH's budget.

The expected tightening of the purse strings in federal life sciences research funds will come just as competition increases for those awards. For example, California — whose life sciences industries and research clusters are at least twice the size of those in Massachusetts — has moved aggressively to create state- and industry-supported university-based research consortia to attract an even larger share of NIH dollars.

FEDERAL RESEARCH FUNDING: N.I.H. DOUBLING HAD AN IMPACT, HARD SCIENCES NEED A SIMILAR COMMITMENT

Total federal R&D spending* in MA, FY2000	Federal spending* for life sciences in MA	Federal spending* for other high tech research in MA
$1.9 billion	$1.4 billion (approx)	$550 million
	Jobs in life sciences	Jobs in high tech
	47,000	225,000

*Academic and non-profit research institutions

Reason No. 3

Massachusetts needs to improve on its poor track record in strategic alliances between public and private universities and businesses.

"In Massachusetts, we have to contact several universities and colleges to put together a program. With each one, we have to learn about their curriculum and their recruitment policies. And we still have to maintain our technology relationship with schools like MIT for development purposes. Other places put all that together for you. They will take the two to three months of lead time to coordinate among their colleges or universities and tell us that, collectively, we have enough to meet your needs — and here's how you begin the process — as opposed to us having to do it on our own here, and spend more than six months to accomplish the same thing."

— Business executive interviewed for Mass Insight's *A Call to Action*

Although they laud the state's universities for developing new science and technology, industry executives we interviewed commonly complain that they also are among the most difficult institutions for companies to deal with. This is particularly true when it comes to small- and mid-sized corporations, which comprise the lion's share of Massachusetts-based technology companies. Research institutions in other states, they noted, do a better job of providing access to their research capabilities.

Moreover, a number of academic and industry leaders we interviewed said that our public and private research universities could accomplish much more if only they would collaborate and cooperate among themselves as well as with industry. And yet, there are precious few such initiatives of which to point.

Massachusetts has a fragmented marketplace for collaborations in both higher education and the private sector. Massachusetts' public higher education system consists of the University system, state colleges, and community colleges, each with their own management and oversight structures, budgets and boards. This makes it extremely difficult for smaller and medium sized companies — the majority of our high tech businesses — to develop collaborative relationships at multiple levels of the state education system.

As one executive put it, "Not too long ago, the Massachusetts economy was dominated by a half dozen or so top players, such as Raytheon, Wang, Data General, and Digital. You could get together a dozen people in an informal way to plan strategies and programs. Then the economy crashed, and the new economy is filled with hundreds of smaller, faster-growing players. Now you have to bring a hundred people to the table."

There are isolated successes. Among them is the new collaboration in bioengineering between UMass Worcester and Worcester Polytechnic Institute (WPI). On the marketplace

side, an example of the possibilities is seen in the relationship Cisco Corp. has entered into with three community colleges — Middlesex, North Shore and Wachusett. Cisco has created "regional academies" and is developing and donating curriculum and training faculty to offer a program through the community colleges in area high schools. The goal is to produce a supply of employees with hard and soft technology skills.

But the community colleges overall are a vastly underused resource in workforce training, a clear example of the problems stemming from the fragmentation of our higher education system.

Another initiative is the TeleCom City University Consortium, in which 11 Massachusetts universities, including Boston University, Northeastern University, Tufts University and the University of Massachusetts system, among others, and Syracuse University in New York, are working on a series of joint applications for federal research grants. Corporate partners include Cisco Systems, British Telecom, Fractal Antenna systems, Nimble Microsystems, Dialout.net, and Telmarc Inc. Joint applications are in the pipeline on bioinformatics and aircraft systems monitoring.

One of the most promising examples of academic/business/government collaboration in Massachusetts is the Engineering in Mass Collaborative (EiMC). EiMC is a collaborative effort of higher education, private industry, state government, and K-12 leaders to promote the pipeline of middle and high school students pursuing studies and careers in science and engineering. This was developed in direct response to the Massachusetts Technology Collaborative Index analyses showing a serious decline in the production of engineers in Massachusetts. While founded by UMass Lowell Dean Krishna Vedula, the effort includes the active participation of private universities such as Tufts (working on engineering in MCAS), WPI (houses the Mass. Math & Science Academy), and Northeastern, and companies such as EMC, Analog Devices, Teradyne, and Fidelity. In fact, the Massachusetts High Tech Council raised several hundred thousand dollars to support a professorship in engineering education at UMass Lowell. It may be the most significant example of public/private university collaboration with industry targeted around a specific state need. However, the EiMC remains a fragile organization, relying on a variety of funding sources and lacking even a modest core investment from the state.

Massachusetts has many islands of scientific excellence — and some promising signs of strategic partnering — but we gain little leverage because we fail to integrate them and support them adequately. The rapidly growing complexity of the science, technology and business opportunities shaping our economic future require a coherent understanding of what we have and where to invest scarce government dollars in the most promising initiatives.

STRATEGIC ALLIANCES: LESSONS FROM CALIFORNIA

KEY ELEMENTS	LESSON
Focus on collaborative efforts	Effective strategic partnerships involve both public and private colleges and universities with a coherent strategy for research and technical needs.
Long-term planning	True university-industry partnerships must be based on long-term strategic needs, not just the hot technology of the moment. Effective collaborations will anticipate the next new sector.
Risk tolerance	Investments in facilities and educational programs may appear risky, but are essential in an increasingly competitive field.

Based on a California analysis of Silicon Valley's relationship with Stanford and Bay Area colleges.

Partnership Spotlight

Large scale university-business collaborations start at the top

"There are so many interesting areas of research in so many schools that it's a challenge to target where to spend our time and money," says Margaret Ashida, IBM's Director of Corporate University Relations. "We zero in on focus areas that are strategic to IBM and then look for schools that have strength in those areas."

While most industry-university collaborations "bubble up" from personal relationships, large-scale partnerships work best when there is an alignment between the interests of the university and the interests of the corporation. The alignment of interests at the top levels facilitates the connections and exchanges of ideas at the more grassroots levels of academic and business research. And the state has a crucial role to play in providing incentives to bring these academic and business interests together, such as programs in New York and California that encourage collaboration through matching funds.

Once corporations identify the most promising R&D centers, they frequently commit executive as well as scientific talent to the task of forming deep, ongoing relationships, sometimes with significant funding attached. While most of the Commonwealth's university-based research is funded by the annual influx of $2 billion in federal research expenditures, industry has also become an increasingly important sponsor — supplying matching grants, endowing chairs, supporting research consortia and, above all, licensing and commercializing innovative technology that springs from the lab. University research administrators interviewed for this report estimate that, on average, about 15 percent of their research funding now comes directly from industry — and they expect that number to grow.

Business leaders emphasized that corporations funding university research no longer think of it as a charitable endeavor, but consider it an important strategic activity that must meet at least two corporate goals. First, the company must gain meaningful access to the most talented students for recruiting purposes. Second, best-in-class technology must be developed that addresses the corporation's strategic product and service goals.

Industry executives we interviewed said universities need to do a much better job of segmenting the industrial market when looking for corporate sponsors and collaborators. Universities tend to be highly decentralized, particularly when it comes to initiating research activities that appeal to particular faculty members. But faculty members frequently fail to consider whether or how their research will support corporate goals.

"The challenge for many universities is that their faculties tend to think of industry partnerships as corporate give-away programs, with no real connection back to the donor," says Sean Rush, General Manager of IBM's global education business and the company's senior state executive in Massachusetts. "IBM has become much more discriminating in how it parcels out research funds. We want to make sure there's much greater alignment between what the universities want to do and what we're trying to achieve. We want strong connections back to our labs and product groups. Universities need to see the research relationship as a truly collaborative partnership, not old-fashioned philanthropy."

Reason No. 4

Massachusetts and its companies must take better advantage of the resources of its private universities, especially Harvard and MIT.

"Why has Silicon Valley created so many more large companies than we have? Think about it: Apple, Intel, Hewlett Packard, Sun and Cisco all benefited greatly by collaborating with Stanford. Many were founded by Stanford faculty. I can point to many Stanford faculty members who move in and out of industry. There's been less of that going on here because of our cultural orientation."

— MIT Chairman Alex d'Arbeloff, Founder, Teradyne, Inc.

Every business executive we interviewed echoed this sentiment .

As noted, all of the large companies we looked at for this report — including IBM, Intel, Raytheon and Sun Microsystems — have already segmented the university research "supply base" to identify the top scientists and institutions in their field that align with their company's strategic goals.

IBM, for example, contributes to over 200 university R&D projects annually and maintains relationships with hundreds of institutions worldwide. The most significant partners are assigned an IBM partnership executive who manages the relationship. In Massachusetts, IBM currently collaborates with MIT, Harvard, Boston University and UMass. IBM has assigned partnership executives to Smith College, in view of its impact on workforce diversity through the Picker Engineering Program, and UMass Amherst, to define areas of mutual interest through research, recruiting, student support, and campus initiatives. Nationally, IBM research awards range from up to $40,000 a year to recognize individual faculty, to a multi-year investment of $100 million in the case of SUNY Albany's Center of Excellence in Nanotechnology.

University and non-profit research labs that fail to understand this process have little hope of linking up with the region's and nation's most research-intensive corporations. And if the universities lose out, so too does the state economy.

MIT's contributions to the Massachusetts economy are legendary — alumni have started more than 1,000 companies and created more than 120,000 jobs in the Commonwealth during the past half-century. But the fact remains that a great many Massachusetts companies

have simply failed to connect with one of the world's premier research institutions, even though it's in their own backyard.

Fully half of MIT's 185 Industrial Liaison Program (ILP) members are foreign corporations. Although the rest are U.S. companies, only a handful are headquartered in Massachusetts. The entry-level fee of $50,000 — which provides access to research in approximately 80 MIT labs — is not a significant barrier to most established high tech companies.

For its part, MIT continues to look for ways to attract collaborators from Massachusetts industry, especially small firms and entrepreneurs.

"MIT has traditionally linked more to larger companies than to the local entrepreneurial community," says d'Arbeloff. MIT's new Deshpande Center — named for the founder of Sycamore Networks, Gururaj "Desh" Deshpande, who contributed $20 million to its creation — is designed to connect small companies and entrepreneurs with MIT researchers by funding collaborative research projects between the two.

"It's an important attempt to change the equation and get MIT research into small, local companies," says d'Arbeloff. "Professors at MIT want financial support for their ideas and don't always see an incentive to get involved with smaller companies."

The Deshpande Center will provide the incentive by funding such research in return for equity or royalties in the new ventures.

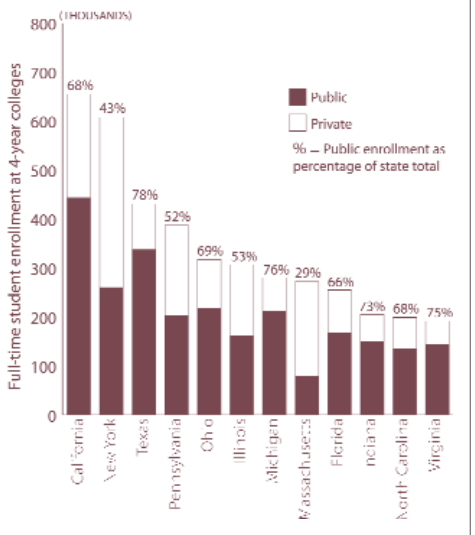
d'Arbeloff, who believes the center could help spark a new wave of innovation in Massachusetts, is seeking to raise additional capital from both public and private sources.

At Harvard, President Lawrence Summers wants to expand university and industry collaborations. Harvard's teaching hospitals have had an extraordinary impact in academic research. But Harvard's impact falls short of MIT's in directly spurring technology industries in Massachusetts.

In fact, nearly everyone we interviewed said that schools like UMass, Worcester Polytechnic Institute, Tufts University, Northeastern University, and Boston University frequently play a more significant role when it comes to collaborating with Massachusetts-based companies. Yet these institutions have nowhere near the financial and staff resources of Harvard and MIT.

Massachusetts and New York both have major private university systems - but New York makes better use of them...

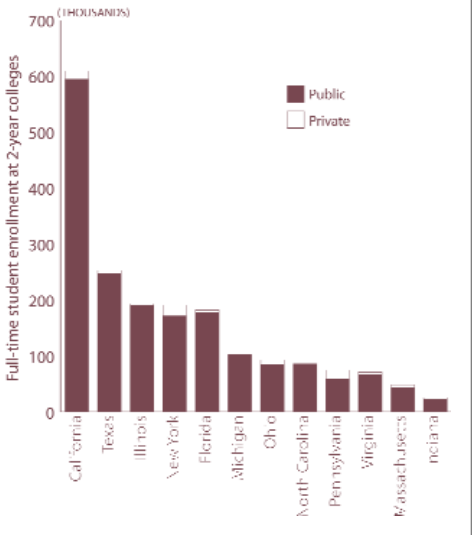
Top Twelve 4-year College States:
Public/Private College Enrollment



Source: US Department of Education, National Center for Education Statistics, Fall 1997

...while Massachusetts community colleges enroll fewer students than all but one of the 12-state group.

Top Twelve 4-year College States:
Community College Enrollment



Source: US Department of Education, National Center for Education Statistics, Fall 1997

Higher Education Spotlight

HARVARD UNIVERSITY
Investing in Cross-Disciplinary Centers

Harvard is tackling the cross-disciplinary trend in life sciences with an unprecedented $200 million investment in four new centers that will pull together scientists from across the university — and later from across the world. Three centers will focus primarily on life sciences, while the fourth will work on computational science.

Harvard believes that future breakthroughs will require cross-disciplinary research that is too expensive and complex for single investigators to manage. While the initial goal is to improve collaboration within Harvard, the University is already looking to extend the program to include partnerships with industry, adopting a model similar to MIT's Industrial Liaison Program. The project is part of Harvard's long-term goal of helping maintain Greater Boston as a world center of biotechnology.

Overseeing the initiative is Fawwaz Habbal, Harvard's Associate Dean for Research and Planning in the Applied Sciences and Engineering Division. Habbal will develop collaborative research and technology licensing relationships between industry and the Division. He wants to create a "professors of practice" program in which visiting scientists on loan from industry will teach courses and conduct research. Extending these centers to industry marks an important evolution in the way Harvard works with the private sector — and holds great promise for the future of the Commonwealth's knowledge-based economy. Says Habbal, "We are in the process of establishing a steering committee to explore what we have for industry. We will then invite industry leaders to seminars to show them what Harvard is doing, because most simply aren't aware of the work going on here. Then we'll start to look for opportunities to collaborate with companies that are interested in the future of a particular technology or that may be interested in sponsoring or directing research. Our third step will be to create industry consortia around particular centers or research activities."

Higher Education Spotlight

WORCESTER POLYTECHNIC INSTITUTE
Leveraging Biomedicine in Central Massachusetts

WPI receives $13 million a year in external research sponsorships. About 75 percent comes from government sources such as the National Science Foundation. While about $3 million per year is received in sponsored research from individual companies and industry consortia, the recently formed Bioengineering Institute features two centers focused on the development of medical devices. WPI and UMass Medical School recently announced the formation of The Center for Comparative

NeuroImaging which, among other things, will develop next generation MRI systems using extremely powerful magnets, innovative RF systems, and advanced image processing systems.

Their goal is to take advantage of the strong biomedical industrial base in central Massachusetts and to leverage WPI's leadership in manufacturing technology. The center promises to make WPI an important resource for medical device makers and bioengineering companies. Another cross-disciplinary project will study untethered medical systems – wearable sensors that allow remote patient monitoring, with potentially great benefits in therapeutics and cost savings.

Higher Education Spotlight

NORTHEASTERN UNIVERSITY
Investing in Research to Become a National Player

Northeastern University, which conducts $40 million in research annually, aspires to become recognized as a national research university. Last year its two-year-old technology licensing office garnered nearly $2 million in revenue, much of it from patents awarded to the Barnett Institute, one of the nation's foremost centers for interdisciplinary research in the molecular sciences. Barnett has an $8 million endowment, employs more than 70 researchers and has 20 corporate sponsors. The Institute's scientists have published more than 800 papers and been awarded more than 50 patents. Current projects include research in DNA sequencing, genetic screening, analysis of recombinant proteins and functional proteomics. Barnett has also begun to spawn startup companies.

Barnett's newest undertaking, the NU Biotechnology Initiative, seeks to raise $100 million to support a world-class center for the study and development of pharmacogenomics, a discipline designed to understand how the products of gene expression affect a patient's response to medication. The research is expected to give rise to more effective pharmaceutical products. Its industrial advisory board, which helps to provide research direction, includes research directors and vice presidents from Pfizer, Merck, Astra-Zeneca, Millennium Pharmaceuticals, Biogen, Genzyme, Arqule, Lexigen and Proteome Inc.

Reason No. 5

In UMass, the Commonwealth has a vastly underutilized resource that could serve as a flagship coordinator for statewide efforts.

"Massachusetts has been slow on the trigger when it comes to state support for university research. If you compare Massachusetts to California, there's an enormous difference in the level of support we provide our state university system. Our goal should be to make the University of Massachusetts look more like California's public universities in terms of state support. If the legislature stepped up more broadly to create centers of excellence in Lowell and Amherst, and committed to making Amherst as prominent in engineering as UC Berkeley, that would have an enormous long-term impact on the Massachusetts economy."

— Ray Stata, Chairman of Analog Devices, Inc.

Business leaders we interviewed agreed on the need to expand collaborations with private universities — and on the state's neglect of UMass. The University of Massachusetts is seriously under-funded when compared to other state university systems. Policy-makers must develop and fund a long-term strategy to put the Commonwealth's public university system at the center of regional economic development. We simply must recognize its pivotal role in our economic well-being, they say.

Indeed, UMass — which in recent years has begun to win a growing number of federal research grants — has suffered severe budget cuts to stem short-term state operating budget shortfalls. Recent budget cuts in public higher education in Massachusetts are among the deepest of any of the leading technology states, while levels of state capital investment in the public research infrastructure are among the smallest. "As an example, the recently-opened $125 million biomedical research center at UMass Worcester was financed entirely with university and private funds, but surely could have benefited from a strategic state investment as well," says UMass' Tom Chmura. On the contrary, states such as New York and California are finding innovative ways to invest in their science and technology future, in some cases by using their capital budgets to fund long-term development projects.

"We have developed certain strengths in new fields such as nanotechnology," says Chmura. "But, in competing for federal grants, we're operating at a disadvantage. Competing institutions such as UC or SUNY have received recent infusions of capital funds for new research facilities and have access to state seed funds and matching S&T grant programs that simply don't exist here in Massachusetts."

Why do Massachusetts policymakers fail to adequately fund UMass? One reason is that Massachusetts is home to so many leading private universities that policymakers can easily be misled into thinking that they play the same economic development role as that of a well-funded public university system. This is a grave error. While Harvard and MIT trigger economic expansion in Massachusetts, doing so is a byproduct of their investments, not a part of their mission.

State universities, on the other hand, are public institutions designed to support local economic well-being and growth.

Since each UMass campus plays a significant role in regional economic development, by under-funding those campuses we are reducing the economic potential of the Merrimack Valley, as well as Northern, Southeastern and Central Massachusetts.

Despite the lack of state resources, UMass takes its regional economic development role seriously. "The university is acting as a catalyst, bringing the right people together and getting them to meet, talk and collaborate," says Fred Byron, Vice Chancellor of Research at UMass Amherst. The school recently won a $600,000 NSF grant to launch the Regional Technology Alliance, which will focus on bringing industry and academic leaders together in a "network" focused on critical technologies and commercial clusters, including information technology, telecommunications, and advanced materials.

Byron hopes these networks of industry and academic scientists and engineers will lead to better research and faster commercialization of new technology. The information technology and telecommunications network has already attracted enough membership revenue to be self-sustaining. The advanced materials network is just getting off the ground, although a number of member companies are already discussing joint ventures with each other and UMass.

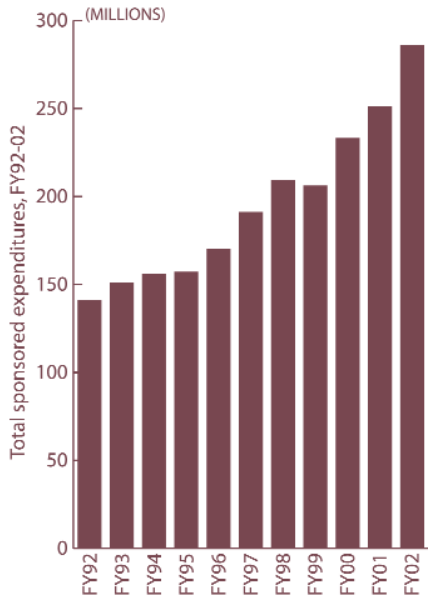
MASSACHUSETTS IS STARVING ITS PUBLIC HIGHER EDUCATION SYSTEM...

New England state	Investment change FY01-FY02	Investment change FY00-FY02
Vermont	8.0%	15.5%
Rhode Island	7.4%	15.0%
Maine	4.8%	12.6%
New Hampshire	6.9%	12.3%
Connecticut	7.9%	9.6%
Massachusetts	(6.2%)	(2.9%)

State flagship university	State spending per student, 2001
UC/Berkeley	$18,109
UMass/Amherst	$10,154

Source: New England Board of Higher Education analysis of data from Center for Higher Education, Illinois State University

...BUT GAINING GROUND IN SPONSORED RESEARCH ACROSS THE UMASS SYSTEM



UMass System Sponsored Research

Annual science and engineering R&D expenditures as reported to NSF

Fortunately, there appears to be a growing sense of UMass' regional importance across the state. Following a recent life sciences seminar hosted by UMass President Bulger, Tom Hubbard, Vice President of the Massachusetts Technology Collaborative commented, "UMass campuses are spotted around the state. They are really the linchpin of creating new technologies, new jobs, new industries in different parts of the state. If, for example, the future for the Pioneer Valley is to get more life science jobs, UMass Amherst is it."

Workforce Spotlight

CITI
Building an IT-Literate Workforce for Massachusetts

The Commonwealth Information Technology Initiative (CITI) is a unique collaborative effort among UMass, the state, and community colleges. It is one of the most important statewide initiatives ever undertaken to address critical information technology workforce issues in the Commonwealth. CITI is improving and expanding IT education at UMass, the other state colleges and community colleges by enhancing curriculum in traditional technical disciplines, and by creating "IT Across the Curriculum" programs in non-technical fields. The ultimate goal of CITI is to create a thriving IT-fluent workforce in Massachusetts. CITI does its work through a program of grants, curriculum enrichment, and creative collaboration between academia and industry. Its impact will be substantial because public higher education institutions educate 177,000 students each year, and an estimated 85 percent of their graduates live and work in Massachusetts.

But CITI has reached a critical point in its development. CITI's programs are at risk because public funding was severely reduced in the ongoing state budget crisis. What was originally designed as a 3-year, $6 million program has seen state funding dramatically reduced in midstream. Thus, CITI has clearly not realized its full potential and has not been able to build on its initial successes. It is now in a holding pattern, seeking industry partners who understand the importance of public higher education and its impact on IT workforce development. CITI's goal is to raise $2 million by the first quarter of 2004 from private and public sources.

Section Two:

Framing an Economic Development Strategy for Massachusetts

What next for Massachusetts?

Framing an Economic Development Strategy for Massachusetts

> "There is a growing recognition that a new science and technology-based economic development strategy is needed for Massachusetts and needed soon. If we work together to sustain the quality of our academic institutions, and build and support businesses that depend on constant innovation, the recovery will be accelerated and enhanced. If we are timid and fail to pursue a coordinated plan, we shall have squandered the legacy that has served our citizens so well for so long."
>
> — William M Bulger, President, University of Massachusetts
>
> — Charles M. Vest, President, Massachusetts Institute of Technology

Massachusetts enjoys an abundance of technology and academic resources. However, absent a better understanding of our science and technology strengths and a state strategy, industry and higher education will continue to be left to compete on their own — often against state-sponsored industry-university consortia involving hundreds of companies and millions of dollars in matching state grants.

Massachusetts companies and universities require more help from state government to maximize their capabilities.

In some cases that assistance will involve "getting out of the way" — e.g., streamlining the state's permitting or procurement to make it easier for important research centers to be built.

In other cases, the state should be an active player to target workforce development strategies or provide matching capital funds to encourage collaborations between UMass and private institutions and businesses.

For all these elements, a *Science and Technology-Based Economic Development Strategy* for Massachusetts would provide the framework around which state government could organize the key players in economic development — the public and private universities and the business community.

In Section Two of *An Economy at Risk*, we recommend a range of policy and strategy options.

A Model Science & Technology-Based Economic Development Strategy: Next Steps and Key Elements

As we stated in the main body of the report, higher education, science, and technology should become the focal point of Massachusetts' economic development policy. Our competitor states have trained their sights on our technology leadership position. We need to respond in kind to meet this challenge and build on our exceptional high technology and university resources.

- **In life sciences**, substantial new federal funding is in place. Three quarters of the $2 billion in federal research funding that Massachusetts wins is for life sciences. The priority is to convert money into research projects and expand collaborations to compete with higher education and business combinations in other states. A shortage of real estate in eastern Massachusetts, state procurement requirements that can double the cost and time of UMass projects, state and local permitting delays and technical workforce gaps hold us back. Finally, the challenge is to bring biotech manufacturing to Massachusetts to get significant employment gains.

- **In the "hard" sciences**, increased federal funding is a major initial priority. The remaining agenda is very similar to the life sciences, with increased support for strategic alliances, real estate and workforce issues at the top of the list.

An economic development strategy framed by science and technology and higher education should address these workforce, real estate, and funding priorities, including community college strategies, real estate and permitting issues for major research projects, requirements for match funding, and a federal funding advocacy agenda for a Massachusetts coalition led by Governor Romney.

Governor Romney should take the following first steps to plan and organize that strategy:

Priority 1: A Cabinet-level Official for Science & Technology Development

Most of our competitor states, including New York, California, Colorado, and Virginia have such a position to support gubernatorial initiatives.

A senior official with the Governor's personal confidence should re-organize economic development strategy around science and technology research and industries, positioning the state to coordinate public and private higher education resources, and plan for and facilitate state and local real estate and workforce development initiatives.

Marketing should be a responsibility for this senior-level position as well. The state must commit itself to establishing high technology corporate headquarters and expansions in Massachusetts, and an aggressive and coordinated marketing effort focused on the research and technology advantages of being located in Massachusetts is a critical step toward that goal.

Priority 2: A Needs Assessment and Technology Road Map in the First 100 Days

Massachusetts needs to ensure that 1) we maintain and build on our research leadership, and 2) the research and technology discoveries achieved here lead to commercialization and manufacturing in Massachusetts.

It is essential that Massachusetts undertake a comprehensive analysis of the significant research centers that link to technology clusters and companies in our regional economies and the specific steps we can take to expand their impact on the local economy. This study should be a cooperative initiative of higher education, high tech and health care industry leaders and the state.

The third-party report should define where our public and private university research and technology strengths lie — in life sciences, defense and aerospace, polymer sciences, and electrical engineering, for example — identify the critical technologies which may fuel the next economic boom, and benchmark our capabilities and needs. The report should establish the role for the state (learning from what competitor states have undertaken) and the potential for new strategic alliances among universities and between universities and technology businesses.

It is essential that Massachusetts undertake a comprehensive analysis of the significant research centers that link to technology clusters and companies in our regional economies.

The team undertaking the assessment must ask the hard questions about our readiness to compete:

- Does the state have the necessary combination of talent, public and private investment, and corporate critical mass to sustain and expand these industries and technologies?
- Is the state positioned to capitalize on emerging global technology opportunities?
- What structures and policies currently in place in Massachusetts successfully support specific industries? What lessons can be learned from them and how can they be applied more broadly?
- What are competitor states doing to enhance their science and technology infrastructure and what can we learn from those efforts?

Once this information has been gathered and quantified, then state leaders can begin to plan and make decisions on new programs and policies.

This Needs Assessment incorporates the Technology Road Map that UMass Lowell's Michael Best recommends earlier in this report. Strategic, forward-looking planning of state funding and coordinated support is essential to preparing our economy for the future. Recent efforts at state strategies have outlined some broad steps for the near term, but none has set a coherent course for state and private sector leaders to follow.

Recent efforts at state strategies have outlined some broad steps for the near term, but none has set a coherent course for state and private sector leaders to follow.

Elements of a State Science and Technology Strategy

There are a number of ways for the state to implement a science and technology-based economic development strategy. What follows are the kinds of initiatives that competitor states have used to support more dynamic partnerships between industry and the state's higher education resources.

Human Capital — A Technology Education Initiative

Led by the Governor and bringing together UMass, the community colleges, and public and private universities with industry participation, this initiative would establish significant education initiatives for the technology sectors. This involves coordinating public and private higher education resources with industry, identifying

workforce needs, and using the public system, particularly community colleges, to prepare students at all levels for the requirements of these industries. Elements would include:

Coordinated Regional Strategies for Community Colleges: The Technology Education Initiative should focus particularly on, for the first time, responding to the continuing calls to establish consistent, market-driven regional strategies for the state's community colleges, for instance to meet the health care and technology sectors' need for more technicians and laboratory personnel. As highlighted in Mass Insight's earlier report, *A Call to Action*, Massachusetts' community college system is highly decentralized and relatively isolated from the rest of the higher education community in the state, compared to systems in other states. The UMass/state college/community college collaboration in information technology education — called the Commonwealth IT Initiative — is a potential model to build upon and expand to other areas such as the life sciences and advanced materials.

The UMass/state college/ community college collaboration in information technology education — called the Commonwealth IT Initiative — is a potential model to build upon and expand to other areas such as the life sciences and advanced materials.

Expanding the Pipeline: The state should consider actions such as the following to recruit and retain science and technology specialists:

- *A Ph.D retention program to retain doctoral graduates in Massachusetts.* Competitor states reward their scientists appropriately for their contributions to the economy and society.

- *An incentive program for researchers and scientists.* A salary pool or other targeted fund for the next wave of scientists could be set up — on a pilot basis — for researchers at public and private universities and research centers. Massachusetts has experienced firsthand how competitive the marketplace can be for top researchers.

- *Recruitment and retention of students in the science and engineering fields.* Nationwide, the number of S&E graduates is declining. The state should consider scholarship and recruitment programs while students are still in high school and employment matching programs and internships for college graduates and graduate students so these students stay in Massachusetts. The current collaboration of public and private universities and private industry in the Engineering in Massachusetts Collaborative can provide a basis for additional efforts in this regard.

Making Our Public Schools Nationally Recognized for Math and Science: While K-12 education reform has shown considerable progress, the focus on math and science education has been more limited (witness the gains students have made on the state's English MCAS tests, as opposed to the math tests, where achievement lags). The new Governor, with the high tech and health care communities as partners, should set a five year goal to make Massachusetts schools known nationally for math and science education. This should include both minimum competencies and higher achievement levels and would require, among other strategies, targeted investments in proven content training for teachers and a systematic effort to recruit highly qualified math and science teachers, competing with other states.

Real Estate and Infrastructure

Real Estate, Procurement and Permitting Issues: These issues are adding increasing pressure on private sector and academic science research operations. In eastern Massachusetts, limited appropriate space for labs and research centers is a serious issue. When space is available, state and local permitting can create anti-competitive delays in projects. And public procurement requirements cause UMass projects to cost twice as much and take twice as long to build as comparable private sector projects.

The new senior-level Administration official should take the lead to identify these issues — including a coordinated and consolidated permitting process for high priority projects, a more efficient state DCAM process, financing, and employee housing — and should work with the private sector and municipalities to streamline permitting and make sure these industries have the space to grow.

This should be a statewide effort. Companies will increasingly look beyond greater Boston to meet their real estate needs. The Administration should facilitate this process by identifying communities that have "technology-friendly" zoning and permitting and transfer those practices to cities and towns that may be seeking to recruit new technology facilities.

Other Infrastructure Priorities: Basic infrastructure that the state invests in or shapes through regulation — for transportation, water, energy and telecommunications — are critical to support regional technology clusters and academic centers. The Administration should use this economic development initiative to identify infrastructure project and funding gaps and establish coordinated priorities to fill those gaps.

The Administration should use this economic development initiative to identify infrastructure project and funding gaps and establish coordinated priorities to fill those gaps.

R&D: Sources of Innovation

Expand Federal Research Funding: Governor Romney should play a personal role in leading a coalition effort to maintain national funding, awarded on a competitive, peer-review basis, for life sciences and increase the funding for physical science research. The national Science Coalition of research universities provides the vehicle for this effort, but Massachusetts needs to establish specific coalitions across New England and with key leaders in other states to make this case. The Massachusetts congressional delegation has played a critical role in the past, but Massachusetts state leaders have rarely placed a sufficient, ongoing priority on the leverage they could provide.

Increased Support for UMass: With its location in five regions of the Commonwealth, UMass should be a driving force in the economic growth of each region and the state's means of establishing strategic research alliances with private universities and business. This is the role New York has established for SUNY. UMass should be more aggressively funded by the state, with targeted regional science and technology research grants and capital investments, as part of a coherent economic strategy. The state should provide support for laboratories and operating funds for research and commercialization.

With its location in five regions of the Commonwealth, UMass should be a driving force in the economic growth of each region and the state's means of establishing strategic research alliances with private universities and business. This is the role New York has established for SUNY.

Matching Capital Program to Promote University/Business Collaborations: Any grant program should be stringently managed with private sector and higher education advisory input and applications subject to rigorous peer review to ensure the integrity and quality of the investments.

The Commonwealth should promote and facilitate expanded collaborations between UMass, Massachusetts businesses and private universities through matching funds, focusing on both large scale opportunities and the need to link smaller and medium-sized high tech companies to university research. Competitor states have used public funds to help these types of relationships flourish.

$50 million added to an annual capital budget that currently totals about $1.2 billion would allow Massachusetts to answer the challenge from states like New York and California. A matching grant program would leverage federal and business grant initiatives for the development of research and production facilities. Several NSF and NIH grant programs now require universities to have a state financial match.

The mission is to provide funding for research projects and centers that have a strategic connection to the technology clusters in Massachusetts. The Commonwealth should begin with pilot programs, learn from the experience, and develop more robust programs in the future.

Commercialization/Support

Incubators: Incubator programs provide facilities and resources to startups. UMass/Lowell has had an effective program in place for several years. Along with providing low-cost space, the Lowell center also aids in providing financial planning, business plan formulation, assistance in accessing venture capital, and other services. Incubators that are closely tied to colleges and universities and provide access to laboratory space, technical support, office needs, and talented faculty and students have proven successful in other states in cultivating the next generation of entrepreneurial visionaries.

Incubators that are closely tied to colleges and universities and provide access to laboratory space, technical support, office needs, and talented faculty and students have proven successful in other states in cultivating the next generation of entrepreneurial visionaries.

For example, in October 1998, Connecticut formally launched a Bioscience Cluster. Overseen by the state sponsored Connecticut United for Research Excellence (CURE), the cluster started with $300,000 in state seed money and $700,000 from industry contributions. Currently, 93 Connecticut organizations are members of CURE. The cluster's activities so far have led to the establishment of a biotech facilities fund totaling $40 million. Administered through Connecticut Innovations, the state's technology investment arm, the fund will underwrite the development of 150,000 square feet of incubator and lab space.

Any Massachusetts initiative should be coordinated with industry associations to identify gaps and build on existing private sector and nonprofit initiatives already underway.

Regional Venture Capital Pools: Venture capital funding for early-stage research companies is largely concentrated in a few areas of the state. In recent years there has been support for creating regional venture pools, funded with private dollars and matched at a certain percentage by the state. The venture pools could be privately run — perhaps in conjunction with the successful Massachusetts Technology Development Corporation — with the state serving in an active role on the board.

Massachusetts already has undertaken one similar such program — the Mass Ventures effort in the Pioneer Valley — with moderate success. In Texas, for example, the Legislature approved the establishment of "CAPCOs," or certified capital

companies, which are state-regulated, privately-owned venture capital funds that invest in early stage companies. Tax credits are available for insurance companies that invest in qualified companies within the state through a CAPCO.

Moving Forward

Private sector/university collaboration and support should be both a short and long-term goal for state government. The steps briefly outlined here are practical initiatives the Administration and the legislature can take to expand the economic impact of our science and high technology industries.

If we do not develop a coherent strategy and take steps to implement it, Massachusetts risks ceding the title of the nation's "science and technology headquarters" in critical technologies to other states — California, New York or Texas — that have well-defined strategies and investments already in place.

Groundbreaking work on technologies is being done in our state (see Appendix I on page 35 for three examples); much of it will have dramatic impacts on how we — and all Americans — live and work.

The question is: *Will Massachusetts also benefit from the jobs and other economic development impacts that this groundbreaking research will produce?*

It is time for Massachusetts state government to play an active role in the development and implementation of these technologies by providing a road map and the tools for higher education and the private sector to work together to the benefit of all the regions of the state. That bond between the ingenuity and dedication of our research pioneers and the resources and experience of our corporate citizens will assure the future of our economic future.

It is time for Massachusetts state government to play an active role in the development and implementation of these technologies by providing a road map and the tools for higher education and the private sector to work together to the benefit of all the regions of the state.

Appendix 1

Profiles of Sample Opportunities for Development

Where do promising opportunities lie for science and technology-related expansion in Massachusetts?

The best answer may be "in every corner of the state." There is no shortage of ideas or potential partners in the Commonwealth. Ample evidence is provided by the Resource Directory of Science & Technology Partnerships in Massachusetts, a follow-up Mass Insight publication to *An Economy at Risk*. The challenge for the state (and for business and higher education leaders) is to provide a similar — or better — level of coherence and structure to the way we help those ideas and partners bring their products successfully to the market.

Three particularly promising high tech areas are described as examples in the following profiles: microphotonics, medical devices, and nanotechnology. Each offers a brilliant future (the field of medical devices, of course, is already delivering substantial returns to the state), but Massachusetts' success in fulfilling the potential held by these technologies will depend in large part on our collective ability to engineer the kinds of strategic alliances that will draw the necessary investments, people, and other resources.

Other states are organizing to become the microphotonics or nanotechnology centers of industry; will Massachusetts leave our success to chance, or will we organize as well?

Technology Spotlight

LIGHT-ON-CHIP: Will Massachusetts Become the Home of Electronic-Photonic Convergence?

A number of business executives we interviewed believe the Commonwealth's most significant communications research activities are being conducted by MIT's Microphotonics Center, which opened in 1993 with a $50,000 seed grant from the NSF-sponsored MIT Center for Materials Science and Engineering. The modest grant was used to catalyze the assembly of a cross-disciplinary team of leading MIT scientists with expertise in materials science and engineering, electrical engineering, computer science, physics, chemistry, chemical engineering, and even management theory. Each of these disciplines will be needed if the Center's scientists hope to one day solve the thorny problems of combining telecommunications and computation on a common optical platform or semiconductor.

First-year collaborations were so productive that the Materials Science Center increased their funding to $500,000 annually the following year. Corporate sponsors soon joined and the Microphotonics Center continued to grow. Today, the Center's research budget exceeds $9 million a year.

Why is microphotonics so crucial to the future of communications and computing? Quite simply, traditional silicon-based electronics are becoming increasingly difficult and expensive to fabricate at the ever-smaller feature size needed to keep pace with Moore's Law, which predicts that computer chips will double in speed every 18 months. Higher speeds require smaller features and complex lithography. Moreover, complex silicon chips can present difficult heat dissipation and energy consumption problems.

Why is microphotonics so crucial to the future of communications and computing? Quite simply, traditional silicon-based electronics are becoming increasingly difficult and expensive to fabricate at the ever-smaller feature size needed to keep pace with Moore's Law.

Photon-based semiconductors will be infinitely more powerful, yet will require less power and generate little or no heat. High bandwidth applications — such as zero-latency, high-definition videoconferencing —will require all-optical switching systems built from optoelectronic components.

While no one has yet produced a fully light-based integrated circuit, the scientists at MIT's Microphotonics Center are well on their way to developing electronic-photonic chips that handle data distribution and clock speed using on-chip light detectors, switches and modulators. Meanwhile, computations will continue to be processed using traditional transistors. Four industrial groups are sponsoring collaborative research with the Microphotonics Center's scientists:

- **Walsin Lihwa Corp.**, a Taiwan-based wire and cable manufacturer, provides

more than $3 million annually to collaborate with MIT scientists on next generation integrated laser diodes, optical lightwave circuit devices for low-cost, dense wavelength-division multiplexing (DWDM) systems in all-optical communications networks.

- **Pirelli Labs** has signed a five-year agreement to provide the Microphotonics Center with more than $2 million a year to research and develop optical integrated circuits using nanotechnology. Visiting scientists from Pirelli Labs and MIT work together in MIT's labs as well as in Pirelli's new 5,000 square meter nanotechnology laboratory near Milan.

- **Applied Materials**, which makes capital equipment for semiconductor foundries, is providing the Microphotonics Center with donated equipment that can be modified to produce optoelectronic chips. The company recently gave MIT wafer fabrication equipment valued at $2.4 million.

- **Analog Devices**, the Norwood-based maker of mixed signal semiconductors, also recently agreed to sponsor the Center's research in optical chip technologies. Of the 1,000 telecommunications companies in Massachusetts, Analog Devices is the first of two local company to collaborate with the Microphotonics Center.

One day, perhaps within a few years, the Microphotonics Center and its industrial sponsors hope to announce that their chips have enabled an all-optical network.

In addition to sponsored research, the Microphotonics Center is supported by two industrial consortia. The Microphotonics Industry Consortium has a dozen members — including Pirelli, Analog Devices, JDS Uniphase, Texas Instruments, and Nortel Networks — who are developing a technology road map for the photonics industry. The road map is similar to the one that guides the traditional electronics industry. It will describe the various technology, economic, and regulatory issues that must be tackled in order for the communications, computer and electronic industries to coalesce around a standard optical platform.

The second consortium has about six members — projected to grow to more than 12 within the coming months — and is focused on fiber-to-wave-guide coupling and packaging, the critical juncture at which optical circuits, switches and fibers must be integrated.

"If only one company were to solve this problem they would own a toll booth on the bridge between communications and computing electronics," says Center Associate Director Dr. George Kenney. "We will share the technology with all the consortium members."

Kenney believes the Microphotonics Center could play the same role in spawning the optical communications and computing industry as the Whitehead Institute

played in fostering the growth of biotechnology in the Boston area. "The money follows the ideas, and the ideas follow the opportunity," says Kenney. "With Whitehead it's so blatantly obvious. All you have to do is walk around Kendall Square. And the role MIT, Harvard and Lincoln Labs played in traditional electronics in the 1970s and '80s is obvious. Where did Ken Olsen and Digital Equipment come from? Lincoln Labs and Project Whirlwind.

"If today you look forward five to ten years, are we going to rest only on the oars of the financial services and biotech sectors? Or do we want to capture the next round of technologies for the Intels of the world: where light moves onto chips?"

The Microphotonics Center may be capturing the attention of leading telecom companies from Italy to Taiwan, but it hasn't sparked much interest in Massachusetts, despite the Commonwealth's oft-repeated claim to industry leadership.

"It's important that local companies, universities and the state coordinate their activities to capture this opportunity," says Kenney. "In other states such as California and New York local companies, universities and philanthropists come together seamlessly and naturally with state government to create regional technology-based initiatives geared toward capturing emerging business growth opportunities."

Kenney hopes local leaders recognize the light-on-chip opportunity before it's too late. He believes Massachusetts could seize a commanding position in photonic-electronic convergence if industry, government and universities cooperate to support a regional processing facility to develop this next generation of chips.

"A full scale facility would require up to 100,000 square feet, with 30,000 square feet of clean room space." Kenney estimates it would cost up to $100 million to build such a facility. And, while MIT has considered building the facility on its own, the cost would be prohibitive. "It would be an incredible regional resource," says Kenney. "Yes, it would accommodate the needs of companies all over the country, all over the world. But the people being trained in the art would be here. It's like saying the Whitehead Institute serves the world, but the biotech industry moved into Cambridge to build around their technology and facility. Why? Because scientists tend to congregate around intellectual centers of excellence. And the students are educated here and want to stay here. The same was true of microelectronics, which emerged from MIT and Lincoln Labs in the 1970s and '80s. And the same could be true of microphotonics. The only question is whether we in Massachusetts take advantage of it or not."

"If today you look forward five to ten years, are we going to rest only on the oars of financial services and biotech sectors? Or do we want to capture the next round of technologies for the Intels of the world: where light moves onto chips?"

— Dr. George Kenney
Associate Director,
MIT Microphotonics Center

Technology Spotlight

MEDICAL DEVICES
Second Only to California — and Trying Harder

The Commonwealth's medical device industry is comprised mainly of small and mid-sized companies — with 44 percent having 50 or fewer employees. Average company sales are between $20 million and $50 million.

However, a number of large medical device-makers can be found in Greater Boston, including Boston Scientific, Genzyme Surgical Products, Hologic, Medtronics, Candela Corp., and U.S. Surgical, which was acquired by Tyco, one of nation's largest medical device manufacturers. The growth of the industry, even without much (if any) state support, is testimony to the dynamic nature of this technology and the value of entrepreneurial partnering.

Leading products developed through close collaboration between Massachusetts industry and universities include minimally invasive surgical techniques and instruments, spinal surgical applications, surgical lasers, and transdermal drug delivery systems. For example, PLC Medical Systems in Franklin has developed a heart laser instrument used in transmyocardial revascularization (TMR), in which a surgeon punches a hole in the heart of a patient who has suffered heart cell death. Blood begins to flow in and revitalizes the heart. TMR offers a new lease on life for people with severe angina when angioplasty and open heart surgery fail. PLC's clinical trials were supported by the Cardiac Department of Brigham and Women's Hospital.

"Our cluster has long been overlooked," says Tom Sommer, President of MassMEDIC, the industry's trade association. "But the medical device industry represents a vibrant and important part of the technology-based landscape in Massachusetts. We have an incredible cluster here and the reason it's growing and continuing to innovate is because Massachusetts has the skilled workforce, academic health centers, leading research institutions and investment capital that together produce this concentration. It is unparalleled on the East Coast. We rank second to California in value-added of medical devices and in terms of industry size.

"California is number one in concentration of medical devices, far and away. They lead in the number of companies, employees, market value, venture capital secured, and annual shipments. The San Diego and Stanford areas are strong, as is Los Angeles to a lesser degree.

"We have an incredible cluster here and the reason it's growing and continuing to innovate is because Massachusetts has the skilled workforce, academic health centers, leading research institutions and investment capital that together produce this concentration."

— Tom Sommer
President, MassMEDIC

"Another vibrant medical device area is Medical Alley in Minnesota. They have a concentration of HMOs, pharmaceuticals, biotech and medical devices, and third party payers. Much of their strength evolved because of the Mayo Clinic."

MassMedic fosters industry-university collaboration through its CEO Leadership Program, which introduces company leaders to the top scientists and administrators from the region's teaching hospitals, including Partners HealthCare (Mass. General Hospital and Brigham & Women's), the Care Group (New England Baptist, Beth Israel, Deaconess), as well as UMass Medical Center and the BU Medical School.

"We bring the teaching hospitals and our companies together to tap into and exploit their resources," says Sommer. "The meetings give rise to clinical trials, technology transfer and collaborative research projects involving the university hospitals and industry. We also have a program to introduce our members to the technology licensing offices of MIT, UMass Medical, Partners Health Care, BU Medical School, and others. So we're a bringing the academic research institutions into contact with industry folks. The goal is to better capitalize on our resources.

"People are always looking to partner more. Northeastern got their tech transfer office going two years ago. WPI has played industry collaboration well. The UMass office of intellectual property is very aggressive in promoting their medical technology. And BU has incredible entrepreneurial spirit. The biomedical engineering program at Northeastern, UMass, WPI, MIT and BU are all major sources of talent and innovative ideas. They all have fabulous faculty and students who contribute to the growth of this industry."

Technology Spotlight

NANOTECHNOLOGY
Small Wonders, Big Opportunities

Nanotechnology involves working with materials and devices at the atomic and molecular levels. But despite the small scale of the science, many believe the future benefits, particularly in biomedical ventures, will be large indeed. "Nanotech is a very major area of strength at UMass as well at other universities in the Commonwealth," says Fred Byron, vice chancellor of research at UMass Amherst. "We have been very successful in competing for federal funds."

Nanotechnology is viewed by many as one of the most significant technology frontiers. Almost every major research university will have a nanotechnology effort in the coming years.

Harvard and MIT have extensive nanotechnology initiatives under way. And at Northeastern, the Nano Manufacturing Research Institute opened in 2001 with a focus on making nanoscales, sensors, devices and circuits. Both the UMass Lowell and Amherst campuses have ongoing nanotechnology research, while MIT recently announced two nano initiatives, the Institute for Soldier Nanotechnologies and the NanoMechanical Technology Laboratory. And a number of Massachusetts companies, including Archemix, BioTrove, Nantera, Phylos, and US Genomics, are active in nanotechnology.

"That's a field where I promise you'll see major things in the next 10 years," Byron says. "Massachusetts is so strong in nanotechnology that it will be a shame if we don't capitalize on it."

If Massachusetts doesn't aggressively pursue a lead role in nanotechnology, others will. New York has already established the Nanoelectronics and Optoelectronics Research and Technology Center at the University of Albany and Rensselaer Polytechnic Institute as a so-called STAR Center. The STAR Centers (Strategically Targeted Academic Research), funded by and large with state funds, focus on basic research with a longer time frame investment. To date, the nanotech STAR Center has not been allocated any funds.

California, meanwhile, has created the California Nanosystems Institute, which has already worked with more than 30 companies, over half of which have offered the institute significant resources. CNSI has archives full of published material that provide ample testament to its achievements.

"Massachusetts is so strong in nanotechnology that it will be a shame if we don't capitalize on it."

— Fred Byron
Vice Chancellor of Research
UMass Amherst

Executive and Higher Education Officials Interviewed for *An Economy at Risk*

Christopher Anderson
President
Massachusetts High Technology Council
Waltham, MA

Margaret Ashida
Director of Corporate University Relations
IBM
Somers, NY

Judy Aydt
Marketing Manager
Intel Research
Beaverton, OR

Wayne Ayers
Chief Economist
Fleet Boston Financial
Boston, MA

Michael Best
Director, Center for Industrial Competitiveness
University of Massachusetts
Lowell, MA

Jan Binda
Public Affairs
Sun Microsystems
Burlington, MA

Cynthia Bloomquist
Associate Director of Corporate Relations
MIT Industrial Liaison Program
Cambridge, MA

Fred Byron
Vice Chancellor for Research
University of Massachusetts
Amherst, MA

Claude Canizares
Associate Provost
MIT and MIT Lincoln Laboratory
Cambridge, MA

Philip Cheney
Vice President of Engineering
Raytheon Company
Lexington, MA

Thomas Chmura
Vice President, Economic Development
University of Massachusetts
Boston, MA

Alex d'Arbeloff
Chairman
MIT Corporation
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Michael Donovan
Associate Vice President
Boston University Medical Center
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William Durgin
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Worcester Polytechnic Institute
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Gerard Eldering
Director of Technology Transfer Office
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David Fleming
Group Senior Vice President, Diagnostics
Genzyme Corporation
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Don Fraser
Executive Director, Photonics Center
Boston University
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Fawwaz Habbal
Associate Dean for Research, Division of Engineering and Applied Sciences
Harvard University
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Ronald Hedlund
Vice Provost for Research and Graduate Education
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Bruce Holbein
Vice President of Public Policy
Massachusetts Software and Internet Council
Boston, MA

Dr. James Howell
President
The Howell Group
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Dr. George "Buzz" Kenney
Associate Director, Microphotonics Industry Consortium
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Bob Kispert
Director of Federal Programs
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Westborough, MA

Herb Kottler
Associate Director
MIT Lincoln Laboratory
Lexington, MA

Dr. Kenneth Luchent
Chairman, Biomedical Engineering
Boston University
Boston, MA

Joseph McManus
Associate Dean for Administration and Finance, School of Veterinary Medicine
Tufts University
North Grafton, MA

Marla Michel
Executive Director
Strategic Technology Alliances and Corporate Relations
University of Massachusetts, Amherst

Appendix II

Dr. Tom Moore
Associate Provost
Human Clinical Research
UMass Medical Center
Worcester, MA

Sandeep Mulgund
Senior Manager, Communications, Information and Electronics
Arthur D. Little
Cambridge, MA

Roberta Nary
Director of Sponsored Programs
Brandeis University
Waltham, MA

Peggy Newell
Associate Provost for Research
Tufts University
Boston, MA

Julie Norris
Director of Sponsored Programs
MIT
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Brenda Philips
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Commonwealth Information Technology Initiative (CITI)
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Dr. Anthony Pirri
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Northeastern University
Technology Licensing Office
Boston, MA

John Pratt
Chief Administrative Officer
The Whitehead Institute
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Martyn Roetter
Vice President,
Communications Technology
Arthur D. Little
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Carolyn Sanzone
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Gregory Sheldon
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Thomas Sommer
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Bob Sproull
Assignment Director and Fellow
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Burlington, MA

Richard Stanton
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UMass Medical Center
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Ray Stata
Chairman
Analog Devices
Norwood, MA

Ashley Stevens
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Jack Turner
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MIT Technology Licensing Office
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Krishna Vedula
Dean, Francis College of Engineering
University of Massachusetts, Lowell
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Jack Warner
Associate Chancellor of Higher Education
UMass Dartmouth
Dartmouth, MA

Bob Wilson
Vice President
Arthur D. Little, Inc.
Acorn Park
Cambridge, MA

Jack Wilson
Chief Executive Officer
UMassOnline
Boston, MA

Executive and Higher Education Officials* Interviewed for *A Call to Action (Fall 2000)*

John Abele
Founder Chairman and Director
Boston Scientific Corporation
Watertown, MA

Christopher Anderson
Vice President & General Counsel
Massachusetts High Technology Council
Waltham, MA

Wayne Ayers
Chief Economist
Fleet Boston Financial
Boston, MA

Ray Bacchetti
Program Officer
The Hewlett Foundation
Menlo Park, CA

Sheri Brodeur
University Programs Manager
Hewlett-Packard Company
Andover, MA

Ross Brown
Vice President, Human Resources
Analog Devices
Norwood, MA

Philip Cheney
Vice President of Engineering
Raytheon Company
Lexington, MA

Thomas Chmura
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UMass, Boston
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Carole Cowan
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Manager, Corporate Real Estate Development
Intel Corporation
Phoenix, AZ

David Fleming
Group Senior Vice President, Diagnostics
Genzyme Corporation
Cambridge, MA

James Gibbons
Reid Weaver Dennis Professor of Electrical Engineering
Stanford University
Stanford, CA

Kay Gilles
Director for University Relations Program
Agilent Technologies
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Richard Gross
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Fidelity Investments
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Paul Harrington
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Center for Labor Market Studies
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Douglas Henton
President
Collaborative Economics
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Managing Director
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Venkatesh Narayanamurti
John A. and Elizabeth S. Armstrong Professor and Dean, Division of Engineering and Applied Sciences
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*Names, titles, and organizations as of Fall 2000

Investing in Our State's Future

by William M. Bulger and Charles M. Vest, 11/17/02

There is a growing recognition that a new science and technology-based economic development strategy is needed for Massachusetts, and needed soon.

Several respected policy organizations — Mass Insight, the Massachusetts High Technology Council, and the Associated Industries of Massachusetts — have emphasized this urgent need.

Our strengths are enormous — including a remarkable concentration of public and private universities, academic medical centers, and an extremely civic-minded business community. Our academic and business institutions have an essential national and global reach, but they also are critical to our future economic vitality. Our universities and hospitals have been powerful competitors for federal research funding and creators of the most highly educated population in the country. Our strong leadership position in biotechnology and in rapidly emerging fields such as computational and systems biology affirm the ability of our faculties to succeed in rigorous national merit-based competitions for federal research funds. We have winning teams in the cutting-edge fields that will shape tomorrow's economy.

Clearly, this college-educated workforce, combined with the innovation that flows from our research universities, has resulted in a prosperous state economy. Indeed, the companies that have emerged from university research have created thousands of jobs and new economic opportunities. University-industry partnerships have added to this dynamic mix. But other states have learned from us and are looking to replicate and expand upon the Massachusetts model. They are investing heavily to beat us at our own game.

These states are making smart investments in their higher education systems, and forging strategic partnerships between their research universities and their core industries. They are undeterred by their fiscal problems. They are, indeed, attracting private and federal support for their science and technology initiatives.

The State University of New York, RPI and IBM have joined to create a national center of excellence. The state of New York has contributed a $50 million investment to this enterprise. California has invested $400 million over four years to establish centers of excellence at its universities. Hundreds of technology companies are contributing millions of dollars to that effort. Texas is investing $300 million in a statewide network of science and research facilities, with $45 million dedicated to product development and business incubators.

Similar stories can be found nearby in Pennsylvania and Connecticut and North Carolina. Massachusetts must have a strategic, coordinated plan or its competitive edge could be lost. Massachusetts — state government, universities, and businesses — must develop a bold science and technology strategy. The Commonwealth, in the past, could rely on the fortuitous results of its higher education presence. That is no longer enough.

The state must take energetic action in pursuit of its own economic interest. We must work to build an innovation system — a system that will support and generate new ideas, transfer those ideas to the marketplace, and educate the next generation of innovators and entrepreneurs.

Five of this state's leading corporate citizens — Ray Stata of Analog Devices, Mike Ruettgers of EMC, Sam Thier of Partners HealthCare, George Chamillard of Teradyne, and Corinne Johnson of GE Aircraft Engines — have offered us a road map worth serious consideration. They have urged the new governor to promote university/industry collaboration, accelerate the development of UMass as a leading-edge technology university, continue the strengthening of K-12 math and science education, play an active role in seeking federal research support by providing matching funds, and establish a cabinet-level science and technology adviser to the governor.

We must commit ourselves and our institutions to work with the new governor, the Legislature, our congressional delegation, the business community, and academic institutions to pursue a new science and technology-based economic development strategy for the Commonwealth.

Even with the Commonwealth's fiscal problems, we need to invest now to maintain our competitive position, which is key to our state's economic recovery.

If we work together to sustain the quality of our academic institutions, and build and support businesses that depend on constant innovation, the recovery will be accelerated and enhanced. If we are timid and fail to pursue a coordinated plan, we shall have squandered the legacy that has served our citizens so well for so long.

William M. Bulger *is president of the University of Massachusetts.* ***Charles M. Vest*** *is the president of the Massachusetts Institute of Technology.*

The Boston Globe *published a slightly shorter version of this editorial on November 17, 2002.*

Since 1989, Mass Insight Corporation has organized leadership groups and facilitated public-private initiatives to improve state performance on issues that have a significant economic impact on Massachusetts.

Mass Insight provides public policy services to businesses, institutions, associations, and government focused on strategic Massachusetts issues. We identify ways to improve government performance and work with groups of public and private sector leaders to put ideas into action. We provide organization and communications support to synthesize complex policy information into a range of accessible, plain-English issue reports; sponsor the longest-running public opinion surveys in the state; and have earned a unique reputation as a public-private facilitator.

Mass Insight organizes its own public-private leadership initiatives when these criteria are met:

- A major competitive priority exists;
- There is no current effort underway;
- Our initiative will have the support and participation of major business groups, public and private sector leaders.

This Winter 2002/2003 Economic Growth Report is the sixth in a series of such annual reports, and is produced as part of an ongoing Science and Technology Initiative.

Methodology for this report

The *Economy at Risk* report builds on and incorporates material from our Fall 2000 *Call to Action: Expanding the Links Between Business and Higher Education in Massachusetts*. For this report, Mass Insight conducted more than 40 formal interviews with senior business executives, higher education officials, and state policymakers, primarily in Massachusetts and New York. Interviewees were asked about a range of issues relating to the links between business development and higher education within the state and in other states and state economic development initiatives. Our selection of executives and officials was designed to include a cross-section of companies and higher education institutions (public, private, four-year and two-year) and individuals who have had experience in Massachusetts and other states.

We also held separate discussions with a number of other experts on higher education's relationship with business and collected data from a broad range of federal and state sources, as well as from Massachusetts organizations such as the Massachusetts Technology Collaborative.

We are deeply grateful to the executives and professionals who provided their perspectives over the course of our research, and to the co-sponsors of the report. Their time and generosity made this report possible.

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